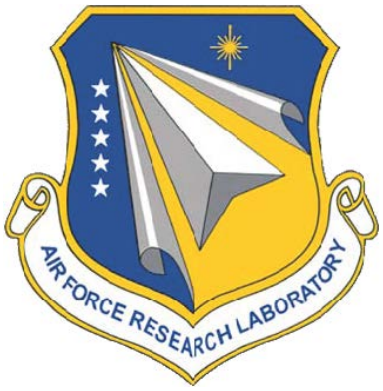

AFRL-SA-WP-SR-2014-0008

En Route Patient Safety: A Mixed-Methods Study

Susan Connor, Susan Dukes, Margaret McNeill, Elizabeth Bridges, Penny Pierce

March 2014

Air Force Research Laboratory
711th Human Performance Wing
School of Aerospace Medicine
Aeromedical Research Department
2510 Fifth St.
Wright-Patterson AFB, OH 45433-7913

NOTICE AND SIGNATURE PAGE

Using Government drawings, specifications, or other data included in this document for any purpose other than Government procurement does not in any way obligate the U.S. Government. The fact that the Government formulated or supplied the drawings, specifications, or other data does not license the holder or any other person or corporation or convey any rights or permission to manufacture, use, or sell any patented invention that may relate to them.

Qualified requestors may obtain copies of this report from the Defense Technical Information Center (DTIC) (http://www.dtic.mil).

AFRL-SA-WP-SR-2014-0008 HAS BEEN REVIEWED AND IS APPROVED FOR PUBLICATION IN ACCORDANCE WITH ASSIGNED DISTRIBUTION STATEMENT.

//SIGNATURE//	//SIGNATURE//
DR. WILLIAM W. DODSON, III	DR. RODGER D. VANDERBEEK
Chief, Selection & Performance Research Div	Chair, Aeromedical Research Dept

This report is published in the interest of scientific and technical information exchange, and its publication does not constitute the Government's approval or disapproval of its ideas or findings.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From – To)*
1 Mar 2014	Special Report	December 2011 – March 2014

4. TITLE AND SUBTITLE

En Route Patient Safety: A Mixed-Methods Study

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Susan Connor, Susan Dukes, Margaret McNeill, Elizabeth Bridges, Penny Pierce

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
USAF School of Aerospace Medicine
Aeromedical Research Dept/FHC
2510 Fifth St.
Wright-Patterson AFB, OH 45433-7913

8. PERFORMING ORGANIZATION REPORT NUMBER

AFRL-SA-WP-SR-2014-0008

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT

Distribution A: Approved for public release; distribution is unlimited. Case Number: 88ABW-2014-2434, 20 May 2014

13. SUPPLEMENTARY NOTES

14. ABSTRACT

Because the en route patient care environment is more complex when compared with ground-based facilities, this mixed-methods study provided a unique insight into the culture, concerns, and possible solutions associated with safe patient management during air staging and aeromedical evacuation (AE). The objectives of this mixed-methods study were to describe the perceived care culture, the gaps associated with en route patient safety, and examine solutions that might close the gaps from the perspective of the en route care providers. An explanatory sequential design was used to obtain both quantitative and qualitative data. During the first phase, quantitative data were collected via a web-based survey from a convenience sample of 236 en route personnel. This was followed by a qualitative study involving eight focus groups (n = 69) to probe and explain the survey findings in more detail. A retrospective patient record review (n = 224) provided additional information on medication discrepancies that occurred en route. Personnel and patient safety were a high priority among air staging and AE units. The most common patient safety missteps appeared to be due to a lapse in attention to detail. Reasons for these lapses seemed to stem from lack of knowledge, time, proper equipment, or physical ability/energy. These deficiencies seemed to contribute to miscommunication related to patient preparation, handoffs, and documentation of medication and/or patient status. Because en route patient care occurs in a less well-controlled environment with little immediate medical backup available, en route care providers need continued education and technical support that parallel the civilian health care system and the aviation industry to meet patient care needs during flight. Adopting the recommendations that surfaced from this research is dependent on the projected costs and benefits to the Department of Defense medical services in general, especially as novel interventions are introduced to manage potentially survivable injuries in modern combat or disasters requiring humanitarian assistance.

15. SUBJECT TERMS
Aeromedical evacuation, en route care, patient safety, patient management

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
					Susan Connor
a. REPORT	b. ABSTRACT	c. THIS PAGE			19b. TELEPHONE NUMBER *(include area code)*
U	U	U	SAR	49	

This page intentionally left blank.

TABLE OF CONTENTS

TABLE OF CONTENTS (concluded)

LIST OF TABLES

ACKNOWLEDGMENT

Funding for this research was part of an AFMSA/SGR Medical RD&A Research Grant. The views expressed in this paper are those of the authors and do not necessarily reflect the views or official policy of the U.S. Air Force, the Department of Defense, or the U.S. Government.

EXECUTIVE SUMMARY

Because the en route patient care environment is more complex when compared with ground-based facilities, this mixed-methods study provided a unique insight into the culture, concerns, and possible solutions associated with safe patient management during air staging and aeromedical evacuation (AE). An important step in improving patient safety is to identify gaps in patient care and examine how air staging team members and AE crew members anticipate, detect, and bridge these gaps.

The objectives of this mixed-methods study were to describe the perceived care culture, the gaps associated with en route patient safety, and examine solutions that might close the gaps from the perspective of the en route care providers.

An explanatory sequential design was used to obtain both quantitative and qualitative data. During the first phase, quantitative data were collected via a web-based survey from a convenience sample of 236 en route personnel. This was followed by a qualitative study involving eight focus groups (n = 69) to probe and explain the survey findings in more detail. A retrospective patient record review (n = 224) provided additional information on medication discrepancies that occurred en route.

Analyses of the survey items suggested that patient and personnel/crew safety is important to those en route care personnel who participated. However, there were mixed thoughts whether the mission or patient safety was more important. Through qualitative analysis of the focus groups' narratives, the culture where en route care is provided appeared to embrace elements of openness, acceptance, justice, learning, and mindfulness. The participants identified six factors that had the potential to hinder the delivery of safe care: equipment, education, the environment, people, communication, and processes. Recommendations to help bridge these gaps included streamlining cumbersome processes, breaking down communication silos, and sustaining AE evidence-based education and practice.

Elements of openness, justice, and mindfulness were evident in the en route culture, which supported the air staging teams' and AE crews' efforts to identify safety issues and initiate corrective actions. Personnel and patient safety were a high priority among air staging and AE units. AE crew members seemed to have had more experience with implementing safety initiatives than the air staging team members. Differences in knowledge and experience related to the airlift mission and en route care might explain the varying perceptions related to patient safety and mission priorities between the air staging teams and AE crews. The most common patient safety missteps appeared to be due to a lapse in attention to detail. Reasons for these lapses seemed to stem from lack of knowledge, time, proper equipment, or physical ability/energy. These deficiencies seemed to contribute to miscommunication related to patient preparation, handoffs, and documentation of medication and/or patient status.

Even though en route care was provided by a mix of military (active duty) and civilian (Guard and Reserve) health care personnel, the importance of teamwork, increasing and applying group knowledge, and designing safe environments through streamlining or implementing technologies surfaced as means to bridge the gaps and improve patient safety. However, rapid rotations and inexperience might have influenced their perceptions that the mission took priority over patient safety. This could result in miscommunication between en route elements as well as sister and coalition forces.

Patient care links the air staging and AE environments, where en route personnel are essential to mission success. Mission success relies on safe patient care and flight practices. Understanding how air staging and AE personnel identify and bridge safety gaps will help transform and strengthen the en route care system as the practice of patient care evolves. Because en route patient care occurs in a less well-controlled environment with little immediate medical backup available, en route care providers need continued education and technical support that parallel the civilian health care system and the aviation industry to meet patient care needs during flight. Adopting the recommendations that surfaced from this research is dependent on the projected costs and benefits to the Department of Defense medical services in general, especially as novel interventions are introduced to manage potentially survivable injuries in modern combat or disasters requiring humanitarian assistance.

Phase I

A Snapshot of En Route Patient Safety

BACKGROUND

When the risks associated with medical care were highlighted by the Institute of Medicine's report [1], the health care industry focused its attention and efforts on bolstering patient safety. En route patient care occurs in a variety of settings; some care is delivered in hospitals, some is delivered in the air, and some is provided in staging facilities located near flight lines.

The aims of this phased exploratory mixed-methods study were to determine within the aeromedical evacuation (AE) system (a) the perceived safety culture, (b) patient safety concerns, (c) possible solutions to en route care patient safety issues, and (d) medication discrepancies in the patient movement records and the potential of these discrepancies to harm the patient. During the first phase, a survey was distributed to air staging and AE personnel to obtain an overall picture of patient safety. A qualitative approach was used for the second phase of the study to gain personal insight into en route care. The third phase of this study was a retrospective review of medication discrepancies. The findings of the survey are discussed in this report.

METHOD

A 24-question survey, adapted from the Air and Surface Transport Nurses Association [2] was used for this cross-sectional study following approvals by the Air Force Survey Control Office (AF11-132SG1), the Air Force Research Laboratory Institutional Review Board (IRB) (F-WR-2011-0163E), and the U. S. Army Medical Research and Materiel Command's Office of Research Protections IRB (M-10237). The web-based En Route Care Patient Safety survey included Likert-type, discrete choice, and open response items. Data were collected from 251 participants and downloaded via secure web into SPSS version 19 (SPSS Inc., Chicago, IL) for analysis. Using descriptive and classical test theory based statistics [3], the demographic data and the psychometric properties and response patterns of the En Route Care Patient Safety Survey were examined. The 13 Likert-type items were examined for missing values, corrected item total correlations (r), and Cronbach's alpha (α). Response patterns, means (M), and standard deviations (SD) were also studied. Qualitative description was used to analyze the open responses of the participants [4,5].

RESULTS

Sample Characteristics

Fifteen surveys were not included in the analysis due to large amounts of missing data (>50%). Therefore, the analytic sample consisted of 236 surveys. The majority of the participants were active duty personnel who were assigned to AE squadrons. Officers and enlisted participants were almost equally represented. There were slight differences in age or years of military service between the air staging and AE participants; however, the AE crew members did have a little more than twice the number of en route care experience (see Table 1).

Table 1. Demographic Characteristics of Survey Participants (N=236)

Characteristic	Air Staging[a] Teams (*n*=77)	Aeromedical[a] Crews (*n*=156)
Component Affiliation, n (%)		
Active Duty	64 (83)	117 (75)
Reserve	8 (10)	35 (22)
Guard	5 (6)	4 (3)
Rank, n (%)		
Officer	35 (45)	99 (63)
Enlisted	42 (55)	57 (37)
Age, yr		
M (*SD*)	34 (11.5)	37 (9.4)
Range	20-57	23-59
Years of Military Service		
M (*SD*)	10 (8.56)	12 (7.38)
Range	0-28	1-32
Years of En Route Care Experience		
M (*SD*)	2.23 (4.20)	5.67 (6.51)
Range	0-24	0-28

[a]Three respondents did not indicate whether they were a member of an air staging team or an AE crew.
Note: The mean age of the 236 participants was 36 (SD=10.2) with a range of 20-59 years. Years of military service ranged from 0–34 with an *M* (*SD*) of 11 (7.90). Percentages calculated for each column and may not add up to 100% due to rounding error.

Quantitative

Item Analysis. Classical test theory based statistics were used to evaluate the psychometric properties and response patterns of the En Route Care Patient Safety Survey that was designed to measure en route care providers' perceptions of patient safety. The 13 Likert-type items were used to measure concepts related to personnel and patient safety. Items were examined for missing values, the corrected item total correlations (*r*), and Cronbach's alpha (α) [3,6,7].

Responses to the 5-point Likert-type questions ranged from 1 (strongly disagree) to 5 (strongly agree). Distributions of the first 12 questions were piled to the right, with the majority of participants agreeing with the questions. However, responses to question 13 were evenly distributed (see Table 2).

Table 2. Summary of Survey Item Responses (N=236)

Question (n = responses)	Strongly Agree n (%)	Agree n (%)	Neutral n (%)	Disagree n (%)	Strongly Disagree n (%)	Mean (SD)	*r*	Skew Kurtosis
1. I can speak up about personnel/crew safety issues. (*n*=236)	184 (78)	40 (17)	8 (3)	2 (0.8)	2 (0.8)	4.70 (.66)	.45	-2.89 10.17
2. I have adequate personnel/crew safety training. (*n*=234)	185 (78)	35 (15)	10 (4)	2 (0.8)	2 (0.8)	4.71 (.67)	.55	-2.85 9.59
3. Personnel/crew safety is a priority in my unit. (*n* = 233)	203 (86)	24 (10)	5 (2)	0	1 (0.4)	4.84 (.48)	.62	-3.92 20.45
4. Personnel/crew safety is a priority among my colleagues. (*n*=234)	175 (74)	51 (22)	8 (3)	0	0	4.71 (.52)	.53	-1.65 1.86
5. My unit is responsive to personnel/crew safety issues identified. (*n*=235)	193 (82)	35 (15)	5 (2)	2 (0.8)	0	4.78 (.51)	.64	-2.73 8.48
6. I have experienced personnel/crew safety initiative implemented in my unit. (*n*=234)	166 (70)	47 (20)	19 (8)	1 (0.4)	1 (0.4)	4.61 (.69)	.59	-1.87 3.70
7. I can speak up about patient safety issues. (*n*=236)	207 (88)	19 (8)	8 (3)	1 (0.4)	1 (0.4)	4.82 (.54)	.55	-3.72 16.24
8. I have adequate patient safety training.(*n*=235)	204 (86)	26 (11)	3 (1)	1 (0.4)	1 (0.4)	4.83 (.49)	.65	-4.07 21.65
9. Patient safety is a priority in my unit. (*n*=234)	211 (89)	17 (7)	5 (2)	1 (0.4)	0	4.87 (.43)	.68	-3.80 15.78
10. Patient safety is a priority among my colleagues. (*n*=235)	201 (85)	28 (12)	5 (2)	1 (0.4)	0	4.83 (.46)	.67	-2.97 9.82
11. My unit is responsive to patient safety issues identified. (*n*=234)	202 (86)	25 (11)	5 (2)	2 (0.8)	0	4.83 (.49)	.63	-3.27 11.96
12. I have experienced patient safety initiatives implemented in my unit. (*n*=236)	184 (78)	37 (16)	13 (6)	1 (0.4)	1 (0.4)	4.70 (.63)	.63	-2.46 7.03
13. Mission accomplishment takes precedence over patient safety in my unit. (*n*=235)	80 (34)	14 (6)	17 (7)	41 (17)	83 (35)	2.85 (1.7)	.08	.211 -1.71

Note: Other than question 13, responses to these questions were negatively skewed, with responses piled up toward the right with the means, suggesting the majority of the participants agreed with the questions. Corrected item total correlations (*r*). Cronbach's alpha for all 13 questions was .80. With question 13 removed, $\alpha = .90$.

The corrected item total correlation helped to discriminate between items that were designed to measure the concept of en route safety. A value less than .30 suggested the item might not correctly measure the underlying construct. Examination of the corrected item total correlations revealed that one item, "Mission accomplishment takes precedence over patient safety in my unit," did not appear to contribute to the measurement of safety ($r = .08$).

A Cronbach's alpha value of .70 was considered an adequate measure of reliability [6]. The alpha value of all 13 Likert-type questions was respectable ($\alpha = .80$). However, Cronbach's alpha indicated that the reliability of the scale improved without question 13 ($\alpha = .90$). Despite this finding, all 13 questions were included for further analyses.

The highest mean scoring items related to the perception that personnel/crew [4.84(.48)] and patient safety [4.87(.43)] were unit priorities. However, "I have experienced personnel/crew

safety initiative implemented in my unit" was the lowest scoring item (*M* = 4.61, *SD* =.69) of the 12 safety questions.

Correlations. Pearson's correlations were used to measure linear associations between the 13 questions (see Table 3). Responses to questions 1 through 12 were positively correlated at the .01 significance level (2-tailed). The strongest correlation (.810) was seen between question 9, "Patient safety is a priority in my unit," and question 10, "Patient safety is a priority among my colleagues." Interestingly, question 9 also had the highest mean (4.87; *SD* = .43).

Table 3. Summary of and Correlations Between En Route Care Patient Safety Survey Questions (N = 236)

Question	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1.	-												
2.	.636[a]	-											
3.	.525[a]	.585[a]	-										
4.	.365[a]	.390[a]	.636[a]	-									
5.	.351[a]	.434[a]	.605[a]	.579[a]	-								
6.	.343[a]	.426[a]	.410[a]	.299[a]	.444[a]	-							
7.	.415[a]	.421[a]	.287[a]	.302[a]	.428[a]	.303[a]	-						
8.	.322[a]	.618[a]	.489[a]	.441[a]	.482[a]	.385[a]	.547[a]	-					
9.	.230[a]	.348[a]	.535[a]	.493[a]	.577[a]	.383[a]	.533[a]	.642[a]	-				
10.	.251[a]	.251[a]	.289[a]	.453[a]	.545[a]	.577[a]	.346[a]	.569[a]	.810[a]	-			
11.	.236[a]	.246[a]	.449[a]	.406[a]	.630[a]	.382[a]	.496[a]	.519[a]	.757[a]	.736[a]	-		
12.	.260[a]	.311[a]	.322[a]	.262[a]	.445[a]	.652[a]	.420[a]	.488[a]	.544[a]	.526[a]	.538[a]	-	
13.	-.022	.001	.003	-.028	.002	.176[a]	.031	.019	.047	.064	.056	.178[a]	-
Mean	4.70	4.71	4.84	4.71	4.78	4.61	4.82	4.83	4.87	4.83	4.83	4.70	2.85
SD	.66	.67	.48	.52	.51	.69	.54	.49	.43	.46	.49	.63	1.7
Range	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5

[a]Correlations are significant at the .01 level (2-tailed).
Note: Possible answers to these 5-point Likert-type questions ranged from 1 (strongly disagree) to 5 (strongly agree).

Group Comparisons. To compare the responses of air staging team members and AE crew members, a series of independent sample *t*-tests was used to test whether the two groups' mean scores on the 13 Likert-type items in the En Route Care Patient Safety Survey were significantly different. The assumptions needed to conduct these tests were met and the sample was divided into two subgroups: air staging and AE (see Table 4).

Findings of these nondirectional *t*-tests suggested that a possible difference between these groups was in how AE crew members (*M* = 4.83, *SD* = .43) seemed to have a more positive perception of being able to speak up about personnel/crew safety issues compared to air staging personnel (*M* = 4.48, *SD* = .88), *t*(231) = 3.26, *p* = .002. AE crew members also perceived they were given ample personnel/crew safety training (*M* = 4.79, *SD* = .59) when compared to air staging team members (*M* = 4.54, *SD* = .79), *t*(229) = 2.42, *p* = .017. Likewise, AE personnel seemed to have experienced more personnel/crew safety initiatives that were implemented in their units (*M* = 4.68, *SD* = .59) than did the air staging personnel (*M* = 4.45, *SD* = .86), *t*(229) = 2.06, *p* = .042.

Table 4. Independent *t*-tests Comparing Air Staging (*n*=77) and AE (*n*=156) Personnel

Survey Item *M* (*SD*)[a]	AE *M* (*SD*)	Air Staging *M* (*SD*)	Mean Difference	95% CI	*t*(df)	*p*
1. I can speak up about personnel/crew safety issues 4.70 (.66)	4.83 (.43)	4.48 (.88)	.346	.14 - .56	3.26(231)	.002
2. I have adequate personnel/ crew safety training 4.71 (.67)	4.79 (.59)	4.54 (.79)	.248	.05 - .50	2.42(229)	.017
3. Personnel/crew safety is a priority in my unit 4.84 (.48)	4.88 (.36)	4.76 (.65)	.117	-.04 - .28	1.45(228)	.151
4. Personnel/crew safety is a priority among my colleagues 4.71 (.52)	4.74 (.48)	4.66 (.60)	.084	-.07 - .24	1.06(229)	.290
5. My unit is responsive to personnel/crew safety issues identified 4.78 (.51)	4.79 (.53)	4.75 (.49)	.045	-.10 - .19	.619(230)	.536
6. I have experienced personnel/crew safety initiatives implemented in my unit 4.61 (.69)	4.68 (.59)	4.45 (.86)	.226	.01 - .44	2.06(229)	.042
7. I can speak up about patient safety issues 4.82 (.54)	4.81 (.59)	4.84 (.43)	-.030	.18 - .12	-.398(231)	.691
8. I have adequate patient safety training 4.83 (.49)	4.83 (.54)	4.84 (.37)	-.012	-.15 - .12	-.173(230)	.863
9. Patient safety is a priority in my unit 4.87 (.43)	4.86 (.43)	4.90 (.42)	-.032	-.15 – .08	-.548(229)	.584
10. Patient safety is a priority among my colleagues 4.83 (.46)	4.81 (.50)	4.87 (.37)	-.061	-.19 - .07	-.941(230)	.348
11. My unit is responsive to patient safety issues identified 4.83 (.49)	4.80 (.55)	4.88 (.32)	-.084	-.20 - .03	-1.46(229)	.146
12. I have experienced patient safety initiatives implemented in my unit 4.70 (.63)	4.72 (.61)	4.66 (.68)	.062	-.11 - .24	.704(231)	.482
13. Mission accomplishment takes precedence over patient safety in my unit 2.85 (1.7)	2.83 (1.71)	2.91 (1.79)	-.081	-.57 - .40	-.334(230)	.739

[a]The overall mean and standard deviation for each item are shown.
[b]CI = confidence interval.
Note: Possible answers to these 5-point Likert-type questions ranged from 1 (strongly disagree) to 5 (strongly agree). A plausible significant difference between the groups was considered at a critical *p*-value $\leq$ .05 [8]. Levene's test confirmed homogeneity of variance

Responses of active flyers and non-flyers were compared using a series of independent sample *t*-tests (see Table 5). Findings of these nondirectional *t*-tests suggested that a possible difference between these groups was in how flyers (M = 4.88, SD = .37) seemed to have a more positive perception of being able to speak up about personnel/crew safety issues compared to non-flyers (M = 4.43, SD = .88), $t(234) = 4.58$, p = <. 001. Those on flying status also perceived they were given adequate personnel/crew safety training (M = 5.86, SD = .45) when compared to non-flyers (M = 4.45, SD = .87), $t(232) = 4.16$, p = <. 001. Likewise, flyers seemed to have

experienced more personnel/crew safety initiatives that were implemented in their units (M = 4.70, SD = .57) than non-flyers (M = 4.46, SD = .84), $t(232) = 2.46$, p =.015. Those on flying status also perceived they had adequate patient safety training (M = 4.90, SD = .38) when compared to non-flyers (M = 4.72, SD = .62), $t(234) = 2.52$, p = .013. Additionally, flyers (M = 4.77, SD = .56) appeared to experience more patient safety initiatives that were initiated in their units than non-flyers (M = 4.59, SD = .72), $t(235) = 2.10$, p = .042. No significant differences were seen between officers and enlisted or component affiliations (e.g., active duty and combined Guard and Reserve duty).

Table 5. Independent *t*-tests Comparing En Route Personnel on Flying (*n*=145) and not on Flying (*n*=91) Status

Survey Item *M* (*SD*)[a]	Flyer *M* (*SD*)	Non-Flyer *M* (*SD*)	Mean Difference	95% CI[b]	*t*(df)	*p*
1. I can speak up about personnel/crew safety issues M = 4.70 (.66)	4.88 (.37)	4.43 (.88)	.447	.25 - .64	4.58(234)	<.001
2. I have adequate personnel/ crew safety training M = 4.71 (.67)	4.86 (.45)	4.45 (.87)	.413	.22 - .61	4.16(232)	<.001
3. Personnel/crew safety is a priority in my unit M = 4.84 (.48)	4.89 (.34)	4.75 (.65)	.136	-.01 - .28	1.84(231)	.068
4. Personnel/crew safety is a priority among my colleagues M = 4.71 (.52)	4.74 (.47)	4.66 (.60)	.082	-.07 - .23	1.10(232)	.275
5. My unit is responsive to personnel/crew safety issues identified M = 4.78 (.51)	4.81 (.49)	4.75 (.55)	.058	-.08 - .20	.846(233)	.399
6. I have experienced personnel/crew safety initiatives implemented in my unit M = 4.61 (.69)	4.70 (.57)	4.46 (.84)	.246	.05 - .44	2.46(232)	.015
7. I can speak up about patient safety issues M = 4.82 (.54)	4.87 (.46)	4.75 (.64)	.123	.03 - .28	1.59(235)	.115
8. I have adequate patient safety training M = 4.83 (.49)	4.90 (.38)	4.72 (.62)	.182	.04 - .33	2.52(234)	.013
9. Patient safety is a priority in my unit M = 4.87 (.43)	4.88 (.39)	4.86 (.49)	.025	-.09 - .14	4.36(233)	.664
10. Patient safety is a priority among my colleagues M = 4.83 (.46)	4.83 (.46)	4.82 (.46)	.007	-.12 - .13	.106(234)	.916
11. My unit is responsive to patient safety issues identified M = 4.83 (.49)	4.81 (.53)	4.85 (.43)	-.034	-.16 - .10	-.514(233)	.608
12. I have experienced patient safety initiatives implemented in my unit M = 4.70 (.63)	4.77 (.56)	4.59 (.72)	.181	.01 - .36	2.10(235)	.042
13. Mission accomplishment takes precedence over patient safety in my unit M = 2.85 (1.7)	2.81 (1.7)	2.94 (1.8)	-.150	-.61 - .31	-.645(234)	.520

[a]The overall mean and standard deviation for each item is shown.
[b]CI = confidence interval.
Note: Possible answers to these 5-point Likert-type questions ranged from 1 (strongly disagree) to 5 (strongly agree). A plausible significant difference between the groups was considered at a critical p-value $\leq$ .05 [8]. Levene's test confirmed homogeneity of variance.

To examine further the significant correlations between question 13 (mission vs. patient safety) and questions 6 (experienced personnel/crew initiatives) and 12 (experienced patient safety initiatives), a chi-square was calculated. There appeared to be a significant association, X^2 (1) = 4.41, p = .036, between those who scored at or *above* the mean on question 12 (experienced patient safety initiatives) and those who scored at or *below* the mean on question 13 (mission vs. patient safety).

The differences between air staging and AE personnel and active flyers and non-flyers were examined further by comparing their responses to three discrete choice questions related to involvement in patient close calls, near misses, or safety incidents. To determine if there is a relationship between duty assignment (e.g., air staging or AE) and participation in a patient safety related incident, Pearson's chi-square tests were calculated. There appeared to be a significant association between duty assignment and involvement in an actual event [X^2 (4) = 17.42, p = .002] and whether or not patient safety initiatives changed because of the incident [X^2 (1) = 12.41, p < .001].

Likewise, there seemed to be a significant relationship between flying status and involvement in an actual event [X^2 (2) = 25.01, p < .001] and whether or not patient safety initiatives changed because of the incident [X^2 (1) = 16.70, p < .001]. Safety incident reporting was not significantly associated with either duty or flying status. Out of the 100 responses to this survey question, 86 (34%) did report an incident, 7 (3%) did not, and 7 (3%) indicated that they preferred not to answer this question.

Qualitative

A mindful awareness of patient safety that was seen in the item analysis was echoed through the words of the participants.

> After 7 years flying AE, I can say patient and crew safety has always been paramount with every unit. Everyone was comfortable speaking up and identifying any concerns … being able to use your experience to anticipate certain problems in the AE movement system is a must to prevent mishaps and identify issues early and often.

Responses to the questions related to actual patient safety incidents were reviewed for commonalities among the survey participants. The majority of the comments (n = 20) were related to equipment malfunction: "malfunctioning ventilator, turned off for no apparent reason … ventilator was changed out…. used an ambu-bag to ventilate patient while switching vents." Lack of access to needed equipment was also described as having the potential of harming the patient.

> The surgeon was trying to get us to use a KCI wound vac dressing with an Impact 326 suction unit going against published guidance. Ultimately we diverted to pick up a KCI Freedom Vac. Turns out the hospital didn't have any approved vacs in inventory. Had we known that we could have brought one with us.

Unsafe patient on- and off-loads were frequently brought out in the narratives (n = 12). Issues seemed to involve the lack of strength of the litter carriers needed to control the litter, rushing on- and off-loads, and miscommunication.

> Patient with transport anxiety and external fixator on lower limb nearly dropped when removed from ambus. CASF [contingency aeromedical staging facility] personnel did not exhibit the strength to offload pt [patient]. Once lowered and control regained, CASF member took control of foot of litter, pts legs (including ex fix) extended past end of litter, and CASF member's rear repeatedly bumped pts legs during litter carry to acft [aircraft] causing pt obvious pain as displayed by facial grimace and groans.

Inadequate patient preparation was commonly brought out in the narratives. These incidents were "usually related to sending facility attention to detail with providing proper equipment, documentation, patient identification, medications."

> Two patients were onloaded with external fixators (one patient bi-laterally and right ex fix on other) without being medicated prior to flight. Mission delayed take-off due to inadequate med-supply hand over from nurse. Mission took off after both patients were medicated and comfortable, documentation required and adequate medication.

The survey respondents also shared comments related to medication issues. Transcription errors, unclear provider orders, inadequate supplies, and mislabeled medications were common issues that could place a patient's safety in jeopardy.

> Patients arrive to plane, many needed pain medications. Two pts had similar names went to give narcotic, po [by mouth] to patient had the wrong chart noticed was wrong when asked the patients DOB…medication orders not being written clearly, orders transcribed to MAR [medication administration record] incorrectly, mislabeled medications and incorrect dosage…wrong medication in PCA [patient-controlled analgesia].

Several survey participants recommended improving and streamlining patient documentation and Department of Defense (DoD) wide communication between the various en route care providers.

> Most importantly, an electronic record that mirrors our colleagues in the civilian community is needed. We need to be able to chart/document with grafts, check-boxes, etc. to minimize long-hand documentation. . . . AE Aircrew Forms Guide should be on hand for them [referring agencies] to reference and emphasize to them that we have limited resources at the flight line/aircraft to trouble shoot discrepancies, and the consequence of missed steps - both for the patient and the mission.

DISCUSSION

Personnel and patient safety was considered a high unit priority. Furthermore, the concepts related to personnel and patient safety were evident in the air staging and AE environments and among those on flying status and those who were not. Findings from this

study suggested that Air Force personnel who were associated with the AE and active flying environments had a more positive perception of personnel and patient safety than those who were connected with air staging and were not on flying status. These differences seemed to involve didactic and empirical knowledge that influenced the understanding of personnel and patient safety concepts, which were strengthened by the experience of implementing actual safety initiatives in the en route care environment.

Another difference appeared to be associated with voicing safety concerns related to personnel issues. However, there did not seem to be any hindrances when patient safety issues needed to be voiced. The reasons given by the survey participants for not reporting the event included "problem was corrected on the spot" and "no harm occurred," which suggested an active safety culture.

Experiences with actual personnel and patient safety initiatives being implemented also seemed to be associated with the participants' perceptions related to whether the mission or patient safety takes precedence. Although responses to this question were fairly evenly distributed, these varying perceptions could lead to miscommunication among various en route care providers and result in patient safety missteps: "ASF [aeromedical staging facility] was running onto aircraft with pt on a litter, the AE crew told the ASF to slow down but they kept on running, one member tripped and almost dropped the patient." Because the mission tempo seemed to push the patient care tempo, concerns related to critical patient care items being overlooked were common.

> Multiple incidents of medications (necessary) missing and equipment missing, and because of trying to have on time take offs or early take offs these items have almost been missed. TACC [Tanker Airlift Control Center] routinely schedules missions over FDT [flight duty time] and CDT [crew duty time] therefore the crew feels the need to rush in order to make up the time. It is not good and the end of the day it becomes a hazard.

LIMITATIONS

Although this cross-sectional survey study provides valuable information related to the en route care environment, any generalizations about the relationships presented in the study should be interpreted cautiously, as this study had several limitations.

Guard and Reserve component personnel were underrepresented in this convenience sample. Biases might have existed due to the retrospective cross-sectional design. The participants self-selected and provided data at a single point in time. It is not known how many eligible individuals who were aware of the study elected to not complete this online survey.

In addition, the context in which this sample of participants worked and lived presumably influenced their self-reported responses to the survey items. Information regarding regional and institutional variations in personnel and patient safety education was lacking, which could have influenced participant answers on the survey.

A ceiling effect was possible. Distribution analyses showed that there was a large concentration of participants' scores on the first 12 Likert-type questions near or at the upper limit (ceiling effect). This scale attenuation threatens the validity of the scale to measure the construct of safety accurately.

CONCLUSIONS

The proverb "experience makes the best teacher" might clarify the differences seen between those who experienced implementation of patient safety initiatives and those who did not see safety concepts applied in their work settings. Experience can influence normative and control factors related to human behavior. Ajzen and Fishbein (p. 195) [9] suggest that the actual performance of a behavior could present new information about the possible outcomes of the behavior, the expectations of others, and control of factors. This new information can work backwards, resulting in the formation or strengthening of a new set of beliefs.

Patient care links the air staging and AE environments where personnel and patient safety is essential to mission success. Understanding how air staging and AE personnel identify and bridge safety gaps will help transform and strengthen the en route care system as the practice of patient care evolves. Continued research into the en route patient care culture, patient safety concerns, and safety recommendation by those who provide care will be informed by the findings from this multi-phased mixed-methods study.

Phase II

Patient Safety: Culture, Concerns, Solutions

BACKGROUND

The past two decades have heralded transformations in the culture of health care and changes in technology related to safe patient care that transcend outpatient and inpatient settings. The safe delivery of care also extends to wounded service members as they transition from a deployed location to the United States. En route care occurs in a complex, team-based environment in which the art and science of patient care are demonstrated beginning with the point of injury that can occur anywhere in the world and culminating at a health care facility located in the United States. Care is continually delivered in a variety of environments on the ground and in the air by a unique mix of health care personnel.

This study was part of a larger research project that was initiated in 2011 to examine various aspects of patient safety. A cross-sectional survey was used to gather an overall picture of patient safety during the first phase of this mixed-methods study. A qualitative approach was used for the second phase of the study. The findings of the qualitative study are described in this section. The third phase of this study was a retrospective review of medical discrepancies from April 2012 to September 2013.

METHOD

Following IRB approval (F-WR-2011-0162N), a focused ethnographic study utilizing focus groups for data collection was employed to identify the state of en route patient safety [10]. The aims of this study were to determine (a) the perceived safety culture within the en route care system, (b) patient safety concerns, and (c) possible solutions that might bolster en route patient safety practices.

Focus group discussions were recorded and transcribed verbatim. To identify commonalities among the informant experiences with patient movement through air staging and strategic aeromedical evacuation environments, a team of researchers familiar with the en route care system used a stepwise approach to data analysis. Verbatim focus group transcripts were downloaded into ATLAS.ti (ATLAS.ti Scientific Software Development GmbH, Berlin, Germany) for analysis. Records of data coding, data reduction, and reflective team discussions were maintained as part of an audit trail. Independent coding by the team was followed by discussion to compare findings and resolve differences. The analysis team confirmed within-case agreement. The perspectives of a separate focus group composed of experienced air staging and AE personnel were used to confirm preliminary findings and cross-case agreement.

Recruitment and Data Collection

Air staging and AE squadrons located in the United States and Europe were invited to participate in this study. Two experienced nurse scientists familiar with qualitative methods

conducted the focus groups. This approach facilitated group discussion. Members' comments stimulated other participants to reflect and elaborate on their experiences related to the en route care environment. Hearing others' comments may have encouraged some participants to express feelings and impressions they may have been keeping to themselves. Participants were recognized as experts on their own interpretations of the en route culture, patient safety concerns, and possible solutions to improve patient safety. Each participant completed a demographic questionnaire and attended a single, approximately 1-hour focus group.

Narrative Analysis

Trustworthiness of the findings was maintained by attending to dependability, confirmability, credibility, and transferability during data collection and analysis. Dependability was enhanced by frequent systemic checks, and all analytical and methodological decisions were preserved as a part of an audit trail [11]. Transcripts used for the analysis represented the verbalized perspectives of the participants word-for-word. Agreement among co-researchers was achieved in the analysis and categorization of data. In addition, matrices and templates confirmed that categories and subcategories were fully represented within and across cases. Cross-verification and triangulation of the data included the perspectives of the participants, which contributed to the credibility of the findings.

RESULTS

Sixty-nine health care personnel volunteered to participate in one of the eight focus groups. Seven to 13 members participated in each of the eight separate focus groups (see Table 6).

DISCUSSION

Active duty, Reserve, and Guard health care personnel who cared for the wounded on their journey from the area of operation to the United States described a strong culture centered on safety. However, equipment, education, the environment, people, communication, and processes were factors that had the potential to hinder the delivery of safe patient care. These concerns and possible solutions were summarized through the lens of the aviation safety initiatives that are imbedded in the education and practice of en route care personnel (see Appendix).

A Culture of Safety

Reason [12] described a safety culture as one that is just, promotes learning, and is informative and flexible. In 2010, the authors of a literature review suggested there were seven subcultures related to patient safety practices: leadership, teamwork, evidence-based, communication, learning, justice, and patient-centered [13]. Within a culture of safety, when an adverse event occurs, the focus in on *what* went wrong, not *who* is the problem. It is a culture of shared accountability [14], but *not* a culture where individuals can make mistakes with impunity or reckless behavior [15].

Table 6. Demographic Characteristics of Focus Group Respondents (N=69)

Characteristic	Air Staging Teams[a] (n=20)	Aeromedical Crews[b] (n=49)
Component Affiliation, n (%)		
Active Duty	18 (90)	26 (53)
Reserve	1 (5)	21 (43)
Guard	1 (5)	2 (4)
Rank, n (%)		
Officer	8 (40)	24 (49)
Enlisted	12 (60)	25 (51)
Age, yr		
M (*SD*)	35 (9.51)	38 (9.594)
Range	22-54	22-59
Years of Military Service		
M (*SD*)	12.2 (7.73)	12.8 (7.69)
Range	2-28	1-32
Months of CASF/ASF Experience		
M (*SD*)	5.15 (10.18)	0.31 (1.23)
Range	0-30	0-8
Months of AE Experience		
M (*SD*)	5.95 (16.0)	86.2 (85.1)
Range	0-63	0-313

[a]Two focus groups were held at staging facilities.
[b]Six focus groups were held at AE squadrons.
Note: The mean (*SD*) age of the 69 participants was 37 (9.60) with a range of 22-59 years. Years of military service ranged from 2–28 with an *M* (*SD*) of 13 (7.65). Percentages calculated for each column and may not add up to 100% due to rounding error.

Even though the AE teams and crews were a mixture of active, Reserve and Guard health care personnel, they described how teamwork and collaboration enabled them to communicate openly and respect each member's contribution to the patient's care. "What worked well was the different experiences and the different ideas of what we bring to the table as far as active duty, Reserve and Guard . . . we pick each other's brains quite often . . . it's good crew resource management."

By creating an open, fair, and just culture, staging teams and AE crews were able to establish a culture of learning that enabled newcomers to incorporate the knowledge and behavior needed to complete the mission effectively.

> I had to teach them how to set up that plane. Then at the end of deployment I saw them take what I taught them and change it . . . they put a strap on each side of the narcotics boxes, that way it was easier to open. I had never seen that ever and now this crew who has never flown on a 130 before came up with that . . . they taught me something and I'm the one who taught them how to set up the airplane. It was cool . . . every mission you learn something.

The five components that define mindfulness also emerged from the participants' descriptions of the en route patient care environment [16]: (1) a constant concern about the possibility of failure even in the most successful endeavors, (2) deference to expertise regardless of rank, (3) an ability to adapt when the unexpected occurs, (4) an ability to concentrate on a specific task while having a sense of the bigger picture, and (5) an ability to flatten hierarchy as best fits the situation.

> You're going from chaos to organization, you're taking [patients] from one environment and putting them into another, you don't want chaos inflight . . . occasionally we have an inflight emergency and it still wasn't chaotic because we had prepared for it, it was in our brief, each person had their role and then when it happened it was a controlled event . . . you have to take into account you're going from a controlled environment to one you have very little control over . . . we intermix crews . . . we all communicate very well . . . no one is afraid to call someone out if they are not doing something safely . . . it doesn't matter what your rank is you can call people out for any safety violation . . . it is a key piece of our safety.

En Route Patient Safety Concerns: Aim 2

In the aviation industry, regulations and protocols are deeply engrained in the culture of all crew members. Moreover, many of the aeromedical programs related to patient safety have been adopted from the aviation industry. Although a just and safe culture seemed to encompass patient care for the wounded warrior, the participants described how equipment, education, the environment, people, communication, and processes affected patient care and posed a possible risk for patients. These common concerns are summarized in concert with the 15 aviation safety initiatives (see Table 7 and Appendix). A deeper understanding of the concerns of the providers can be obtained through the descriptions of their experiences with en route care.

Table 7. Summary of En Route Care Providers' Perceived Patient Safety Concerns

Safety Initiative	ASF (*Invisible Ports-of-Call*)	AE (*Going from Chaos to Control*)
Checklists	• Use of jargon among AE crews and deploying personnel that is home-base specific	• At times crew overtasked with EHR, patient care, and flight safety requirements during critical phases of flight
Crew resource management	• Untrained, lack of credentials, physical capabilities of personnel (includes volunteers) • Overstepping standards of practice related to technicians medicating patients	• Inexperience of newly trained crew members limits forward thinking and situational awareness • Crew needed to assist with on- and off-loading patients in addition to usual duties • Active duty techs expected to medicate patients; a different standard is used for Guard and Reserve techs

Table 7. Summary of En Route Care Providers' Perceived Patient Safety Concerns (continued)

Safety Initiative	ASF (*Invisible Ports-of-Call*)	AE (*Going from Chaos to Control*)
Joint safety briefings	• Personnel unable to lift patient litters safely • Personnel unable to provide patient care	• Patient briefings at handoff are inconsistent and incomplete • No opportunity to debrief with ASF/CASF teams • Lack of timely feedback related to reported safety issues • Same issues documented several times
Minimum safety requirements	• Flight line security and safety breaches • Lack of appropriate anti-hijacking procedures and documentation • Fatigue of core staff members	• Patient care equipment is not fully charged due to lack of access to adequate outlets and/or electricity • Patient equipment charge cords are missing • Lack of required patient care resources (esp. with psych patients) • Civilians seem have their own rules when it comes to patient handoffs • Ramp control is almost impossible at several locations
Sterile cockpit rule	• Lack of control due to mobs of people who meet and wander onto the plane	• Lack of ramp and forward crew door control during patient handoffs due to large number of inexperienced personnel who meet the plane
Alternation of roles	• Unable to alternate out core staff with deploying team members due to constant changeovers and need to use civilians to augment team	• Disparity of experience between active, Reserve, and Guard personnel decreases alteration of roles. • Differences in flight line and aircraft control expectations of Army, Navy, and Air Force enhances chaos during patient handoffs
Standard layout	• Frequent rotation of deploying teams requires constant reworking of processes to accommodate personalities and capabilities • Use of multiple forms to document patient care	• Constant shifting of patients to accommodate cargo or changes in on-load number and needs of patients
Black box	• Multiple sources of patient information; lack of real-time information on medications and secondary diagnosis	• No real-time visibility of supplies across the spectrum • EHR is cumbersome and time consuming • Lack of real-time patient information prior to landing (patient evaluations occur when they arrive at the plane)

Table 7. Summary of En Route Care Providers' Perceived Patient Safety Concerns (continued)

Safety Initiative	ASF (*Invisible Ports-of-Call*)	AE (*Going from Chaos to Control*)
Corporate responsibility for training	• Nurses who cannot provide needed care are assigned to team • Improper litter lifting techniques • Camp Bullis training is not effective	• Outdated OI (41-307): not currently evidence-based • Diverse experience levels and use of home-base mind-sets lead to communication issues regarding mission requirements • Education regarding mission/roles across the en route care system is not consistent among Guard, Reserve, and active duty technicians and nurses • Lack of sister services' understanding of required patient care supplies and patient safety concerns • EMED training is scattered • Lack inpatient experiences of active duty nurses • Ground patient care sites lack understanding of operational security driven mission timing and changes • Army, Navy, volunteers, and civilians who meet the planes lack proper safety training
First-names-only rule	• MCD often refuses to give report to AIC (ASF team member)	• Concern who should receive patient reports (i.e., non-medical or technician)
Incentivized no-fault reporting	• No timely feedback on safety issues elevated to MDG/AMC	• Mission confusion due to lack of training or deployment mind-sets promotes in finger-pointing and pulling rank
Bottle-to-throttle rule	• Core staff fatigue due to need to fill-in where deploying staff or volunteers are unable or incapable	• Lack of consensus among Guard, Reserve, and active duty understanding of crew rest requirements • Crew loses focus during Andrews to Kelly leg of mission
Mistake-proofing	• Multiple, often contradictory sources of patient information • Little or no medication reconciliation throughout the system • Multiple, sometimes contradictory guidelines from MDG and AMC • Unsafe, confused approach to patient on-/off-loading due to lack of training or physical ability of volunteers	• Handoff reports incomplete and not standardized • Patient preparation incomplete and not standardized • Need to access multiple sources to get a clear picture of current patient status, doctor's orders, and medications • Lack of time to review and confirm patient care needs prior to take-off: due to all of the above • Told by deployed leadership that AFIs and rules do not apply

Table 7. Summary of En Route Care Providers' Perceived Patient Safety Concerns (concluded)

Safety Initiative	ASF (*Invisible Ports-of-Call*)	AE (*Going from Chaos to Control*)
Forcing functions	• Lack of continuity due to absence of real-time patient information that is vital when multiple providers at various locations treat patients (providers are unable to obtain a clear picture of the patient)	• Lack of sister service knowledge of roles related to safe patient preparation and flight line safety • Inability to identify essential ground personnel who oversee patient on- and off-loads • Lack of experience can result in accidental override of safety parameters related to patient equipment; likewise, expertise with equipment could be used to correct for inappropriate safety settings, but "expert" is prohibited by AFI to alter parameters
Flight envelope protection		• Patient's exposure to extreme environmental conditions (heat, dry, fumes); concern regarding impact on stressed physical and mental health • Lack of access to electricity needed for equipment charging • Lack of communication between crew and GPMRC regarding patient movement needs and comfort level of crew to meet needs during flight

Notes: AFI = Air Force instruction; AMC = Air Mobility Command; EHR = electronic health record; EMED = emergency medical; GPMRC = Global Patient Movement Requirements Center; MCD = medical crew director; MDG = Medical Group; OI = operating instruction.

Equipment. Technology and pharmacological agents are important adjuncts to any patient care. However, when these adjuncts are not available, safe patient staging and transport may be jeopardized. "Patient prep and medications are big . . . patients come out with the wrong drugs or not enough drugs or patients coming out with equipment but not the plugs for the equipment so we can't use it."

Before equipment is used during flight, it undergoes extensive research and testing to ensure it will operate properly at altitude without interfering with aircraft systems. Yet at some austere health care environments, space and time on the electricity grid are limited.

> We have a space issue, and we can only charge so many pieces of equipment, so as soon as it comes to charge, i.e., hits 7.8 amps or whatever, then they unplug it and put the next piece on . . . they never fully charge . . . then they die in the middle of the mission.

Due to these limited resources, crews "have to give them our equipment . . . whoever is dropping them off or picking them up a lot of patients, we will have to give them our stuff."

Education. For many, basic education related to the aeromedical mission is provided through two standardized courses [e.g., flight nurse and aeromedical technician course and the Flight Training Unit (FTU)]. "Qualified flyers who are coming from the FTU, they're not quite ready . . . [the FTU believes] when they come to our unit they can get on the plane and take care of patients, but it's not reality." Likewise, members of the staging teams described the training they received did not help them meet their mission: "the Air Force spent $3500 for me to go for

1 week . . . it would be a better use of money to just send me to my base and let me learn hands-on."

Although supplemental guidance regarding practice and behavior is published by the Air Force, it did not seem to keep pace with advances in health care practices: "they need to update our 41307 . . . it is 10 years old this year, it's antiquated . . . our level of what we can do has changed . . . it's difficult having to stick to those regs when you know it doesn't make sense." This lag between current evidence-based practice and Air Force guidance frustrated some of the participants who were experienced and considered themselves competent to perform patient care measures that were restricted by AFI.

> My patients have fiddled those things [PCA] completely apart . . . put it back together, reprogrammed the darn thing . . . I know how the thing works, I know how it's programmed, I'm good to go. As an AE crew, I have to shut it off, unplug it and go back to giving up the horses, it's frustrating.

The all-volunteer nature of the Armed Forces brings together en route care personnel with varied backgrounds and experiences. Thus, published Air Force guidance may be challenging to follow: "we're reservist so most of us have day jobs and we work different shifts and we have different backgrounds . . . It's expected you do the active duty standard which is actually not our standard."

Environment. "Everyone has their own ISM [sic], we have our own ISM," which required en route care teams and crews to adapt to the tempo, rules, roles, and expectations of the interservice agency overseeing the area's operations: "they don't know our standards . . . they don't have the same standards, they don't anticipate the same. . . .there is a deployment mentality too. When we go, they think the rules relax because we are at war. They think we can cut corners."

En route care teams support a patient's transition between several unique care environments. However, sister and coalition personnel did not seem to be aware of potential patient safety issues.

> The Army would come running and deliver the patient to the aircraft ramp, set them down in the JP fumes, and there is a patient on a litter on a gator and the guy is just lying there and the guy is right in the heat of the prop lodge . . . it was like being in a microwave, they are just sweating like crazy . . . we don't know how long it has been since they have had water.

Limited availability of resources (e.g., time, equipment, manpower) and duplication of operational oversight might result in some functions being carried out by civilian agencies. Yet, what appeared as a viable option actually created more work for en route care teams to meet mission requirements and safe patient care. "We have issues with a secure flight line . . . two different wings trying to get them [civilian] flight line badges . . . without us they can't get on, we do their antihijacking too . . . we do their mission/job." Likewise, limited manpower was problematic when patients required an escort.

> I had a female psych patient with a significant diagnosis . . . the patient should have had a female escort. When the ground transport came out it was all males. Did you have any idea of what the patient's diagnosis was? Did you have a 3899? Oh yeah, then why is there no female with this patient. We only have one female to send.

The lack of adequate manpower required crews to adapt, which strained AE crew resources and had the potential to create an unsafe environment. "We had 17 [patients], and there will be 2 people to load litters and then your crew is loading the litters and then you have your nurse doing hand off by herself."

People. Not only did the lack of manpower and training put patients at risk for injury, but also a lack of physical strength needed to lift and control a 200- to 300-pound patient litter was a common concern.

> They don't always have people to help or don't have the training . . . we are using a lot of volunteers to get them from the bus or ambulance to the airplane. The crews are volunteering to teach whoever shows up. But you can't be two places at once . . . there were so many volunteers . . . some were civilians and some of them almost dropped patients. They say 'I can do this, I can do this,' but they can't. They made it worse.

The variety of patient care experience also complicated patient care: "people aren't meeting the criteria . . . you get what you get . . . I get nurses who have never touched a patient in 10 years and in 3 days they are expected to know the mission and be able to care for patients." The experience gap of nurses and technicians was echoed throughout the narratives as many DoD health care facilities continue to change their focus from inpatient to outpatient care.

> What I learned as a nurse, I didn't learn from the military, I got it all civilian side. I don't think the Reserves have that kind of problem because our nurses come to us as nurses . . . personally I will take an active duty tech anytime over a Reserve and I will take a Reserve nurse over an active duty nurse any time.

Communication. The variety of backgrounds, learned roles, and expectations created gaps in communication between elements of en route care teams and crews. "We all have our different types of communication . . . [those without] flight experience use a word and it means something to us. Those that do have flight experience may use the same word but it means something different to them." Because of these gaps, each element did not seem to have a clear picture of how they supported the overall mission.

> Having worked the CASF, I never understood why the flight nurses wanted me to do everything before the patient got on the plane. I was never told that there's a limit to how many people can come on the plane and I was never told they have control over who comes on the plane. So when someone hasn't seen a mission and I go out to the plane, I say you wanna come?

This narrow perspective extends outside the Air Force. "They didn't understand that we weren't just taking a little flight and we're putting them in another hospital . . . we're just an invisible port-of-call . . . even the patients don't know they're stopping here, they think they are flying straight to Texas."

Conflicting perspectives furthered miscommunication between en route elements. In an effort to obtain an accurate patient status report, the staging crews voiced concerns that "the biggest issue as far as taking report from the MCD is it's always second hand." However, several nurses who filled the MCD roles voiced concern: "and you are giving report to an enlisted med tech and most of the time they are non-medical." Likewise, many participants thought their assessment of the patient or situation were discounted by personnel who did not have an eyes-on perspective: "TACC and GPMRC, honestly they don't care about you much. You have to be your own advocate . . . I felt that they didn't trust us to make decisions for our crew while we were there."

Due to the pace of the mission, AE crews rely on accurate patient information, especially when planning for safe movement and placement during on- and off-loads.

> It's hard, you don't really see the thing about the X-fixes [external fixator], you don't really see whether or not what type of patient or if their X-fix is on the right side or the left side or just… you have 15 minutes to look at it [the load plan] while you're offloading cargo and trying to make your changes.

Communication gaps between several operational agencies might place patients and en route health care personnel at risk for exposure to and transmission of disease.

> We answer to the Med Group on a lot of stuff but we also answer to AMC on a lot of stuff . . . I have to pull MGIs [Medical Group instructions] and AFIs [Air Force Instructions] from the Medical Group . . . then I pull flight line and AE regulations . . . what scares me is there an AFI out there that I don't know about that I should know about . . . a little more guidance instead of feeling like you're hybrid would be nice especially when we have to deal with this multidrug resistant *Acinetobacter,* I have to really sit there and think, OK should we abide by this reg or not.

These communication silos could place the patient at risk for harm. Consistent evidence-based practice requires continuing patient assessments and changes to care plans as best fits patients' needs as they move through the en route system. Accurate real-time patient information is essential to providing safe patient care. However, timely, accurate patient information was a common concern discussed by flight surgeons, nurses, pharmacists, and technicians.

> When [the patient sees] four or five providers and goes through the system real quick. Mistakes are made. I don't have access to Landstuhl's inpatient records, so I'm already going off the 3899 in TRACES which also inputs PMR, AHLTA, AHLTA-T, CHCS [different electronic software containing patient information] . . . then if someone comes from Landstuhl . . . the patient will say well I'm on this med . . .I'm asking why on this med? I gotta know. I can't pull up the docs record so, I can't pull up the neurologists record and say this is why I'm giving it, I think.

The lack of feedback to en route personnel who reported mission mishaps or near-misses may eventually result in decreased reporting: "I feel I've been writing the same stuff out for 8 months . . . the 2852s that go through the system over and over and over . . . by the time it actually gets back or if it gets back to that unit, they're in new rotations." This lack of feedback might also limit the opportunity for en route health care personnel to enhance their learning: "I don't think there has ever been a forum for us to know how our patients made it through the system. Or if we could have been a cause of an issue up chain but you wouldn't know about it."

Processes. The impact of "ISMs" and available resources confounded safe en route care: "one of the big hindrances, is that we don't understand, we don't know each other's processes, processes that we think are happening but they're not."

Constant turnover of personnel and the lack of overlap between leadership required efficient processes to be changed.

> The permanent party here will come up with a plan on how we want to work things and it has to reflect on that deployment team and it'll work for that deployment team and then 3 months later a new deployment team will come in and because it's different personalities and different experiences, our whole plan has to change on how we manage the mission.

The en route care system is part of a larger airlift operation used for a wide variety of missions other than patient movement. En route care process are regulated by the Air Force, but the diverse patient care practices of sister services and coalition forces were a concern as en route care providers experienced a mixture of patient care related documentation.

> We're seeing doctor's orders on this piece of paper and on this piece of paper we are seeing physician assistant order's . . . then there were flight surgeon orders on the 3899Bs which is where they're supposed to document but they're also embedded in the SOAP note. They were putting orders on the MAR, which is 3899I. So how in the world are you supposed to know what the orders are anymore?

Airframes are a multi-use asset, and AE crews operate in the medical and operational arenas that require them to maximize asset use, yet keeping patient safety in mind. "If we move the patient this way, we can have two more pallet positions, and we can maybe take on an extra pallet of cargo." However, issues can surface when the expectations of two elements conflict: "ATOC [Air Tactical Operations Center] is not familiar with what we can carry . . . they want us carrying certain things back to Germany when you go and you can't because you have certain patients."

When processes are not efficient or are confusing, personnel might develop a work-around that might affect patient safety.

> I think you can find that sometimes the safest way may not be the most efficient way. So sometimes, you can see some compromise. It's not completely unsafe; it's just not the safest way you can do things. . . . the person's a SAM [self-administered medication] okay, great and who knows, there's no check later on that the patient has the medication on them . . . if you're going to get the patients out then you're going to have to let some of this stuff slide because it's not

feasible that you're going to get all this stuff lined up in a row . . . people aren't taking the time to take each chart, look and see what meds are ordered, and know what meds are coming with each patient.

Aim 3: Possible Solutions

The aviation safety initiatives were designed to emphasize teamwork [17]. Additionally, Air Force regulations and published evidence-based guidelines steer aircrew education and practice so when an unusual situation arises, individuals follow set procedures and report issues through the chain-of-command rather than trying to find a work-around. However, concerns related to cumbersome processes, communication silos, and differences in clinical experience have complicated mission accomplishment that might place a patient at risk for harm. Table 8 summarizes the suggestions the en route providers' proposed to facilitate en route patient safety.

Table 8. Possible Solutions to En Route Safety Concerns

Safety Initiative	ASF	AE
Checklists	• Standardize patient handoff	• Standardize patient handoff
Crew resource management	• Train manpower pool in flight line safety and patient litter lifting techniques	• Train manpower pool in flight line safety and patient litter lifting techniques
Joint safety briefings	• Standardize patient reporting during ASF-AE–ASF handoffs	• Build communication bridges among sister services and communicate flight line and patient safety during handoffs (i.e., liaisons who are oriented to AF way of doing missions) • Provide feedback on safety issues that were documented during flight
Minimum safety requirements	• Require physical standards met for assigned personnel • Provide nurses with current patient care experience • Require contractors to conduct and provide documentation of anti-hijacking • Require civilian contractors to have ambulance drivers with appropriate flight line training and clearances	• Provide education to sister services regarding AE and ASF safety requirements during patient transfers between ASFs and AE crew • Standardize AE admission orders • Install a patient call bell/light system • Have ambulatory patients hand carry SAM on plane in a clear plastic bag (similar to commercial flight requirements)
Sterile cockpit rule	• Improve environmental control of patient handoffs during on- and off-loading	• Identify essential ground personnel with vests or hats to improve ramp control and safe patient movement
Alternation of roles	• Provide orientation to AE processes	• Alternate AE and ASF crews • Include Army and Navy personnel in ASF and AE crews
Standard layout	• Allow overlap between deploying personnel to facilitate transitions and continuity	• Standardize real-time communication regarding patient status and load plans • Streamline and consolidate patient information

Table 8. Possible Solutions to En Route Safety Concerns (concluded)

Safety Initiative	ASF	AE
Black box	• Consolidate patient and flight information to increase visibility and continuity of patient care	• Streamline EHR and make real-time patient information available to flight nurses • Investigate possibility of voice or handwriting recognition technology to facilitate patient charting
Corporate responsibility for training	• Rework training at Camp Bullis to include more time at assigned ASF • Update 41-307	• Update 41-307 • Combine EMED training into one course • Provide basic AE training for Navy/Army liaisons • Provide active duty consistent inpatient care experiences prior to flying assignments
First-names-only rule		• Clarify who can or should receive patient report during handoff (i.e., civilian ambulance drivers, non-medical NCO, etc.)
Incentivized no-fault reporting		
Bottle-to-throttle rule		• Provide better guidance on crew rest policies
Mistake-proofing	• Encourage continuity binders and incorporate standard process into regulations • Improve communication between military treatment facilities & AMC; train consistent manpower pool to help with on- and off-loading patients • Improve medication reconciliation across the system	• Keep patient care regulations current and evidence based; increase efficiency of process (esp. patient information, patient handoff, litter handling) • Streamline patient records (one-stop-shop) • Implement medication reconciliation system across all services
Forcing functions	• Standardize terminology and processes among en route care roles	• Consider pyxis-type equipment on flights with AE formulary and supply available to all services involved with en route care; consider bar coding patient, medication, and bags • Incorporate automatic medication and name alerts into EHR • Overlap leadership at deployed sites to enhance mission continuity
Flight envelope protection		• Consider increasing crew augmentation (especially during leg between Andrews and Kelly and missions with large loads) when expectations could exceed crew's limits • Evaluate flight line conditions that might result in patient compromise due to dehydration, overheating/chilling, and exhaust fumes and consider environmental options that might lessen stresses

The concepts of counter-heroism, common knowledge, and ergonomics have been used to evaluate the cost effectiveness associated with implementing patient safety initiatives [18]. Table 9 summarizes how frequently the informants discussed the safety initiatives that they advocated for to improve en route patient safety.

Table 9. Summary of Suggested Modifications by En Route Providers

Safety Initiative	Counter-Heroism (Overcome Excessive Individualism and/or Rankism)		Common Knowledge (Guide or Enhance Group Knowledge)		Ergonomics (Careful Design to Overcome Human Error)	
Checklists			▲	■		
Crew resource management	▲	■	▲	■ ■ ■	▲	■ ■
Joint safety briefings			▲	■ ■	▲	
Minimum safety requirements		■	▲▲▲	■ ■	▲▲	■ ■ ■
Sterile cockpit rule			▲	■	▲	■ ■ ■
Alternation of roles	▲	■		■		■
Standard layout			▲	■ ■ ■	▲	■
Black box			▲	■ ■ ■	▲	
Corporate responsibility for training	▲		▲▲		▲▲	
First-names-only rule	▲					
Incentivized no-fault reporting		■		■		■ ■
Bottle-to-throttle rule[a]				■		■ ■
Mistake-proofing		■	▲▲	■ ■	▲▲▲	■ ■
Forcing functions			▲▲	■	▲▲	■
Flight envelope protection				■	▲	■

[a]This rule also applies to crew rest.
Key: ASF/CASF teams' concerns related to patient safety: ▲ low (n ≤ 4), ▲▲ medium (n = 5-9), ▲▲▲ high (n ≥ 10). AE crews' concerns related to patient safety: ■ low (n ≤ 4), ■ ■ medium (n = 5-9), ■ ■ ■ high (n ≥ 10).

Counter-Heroism and Counter-Rankism. The passion for the mission and the compassion for the patients were strong motivators for en route team members to "do whatever it takes" to complete the mission. However, the need to overcome deficiencies in the system or the team resulted in volunteers dropping or mishandling patients and acts of heroism.

> I don't want anyone else taking care of them because I know the care I am going to give them. I am going to give it my all every time. I really pride myself on that I know that when that patient is in my care they're going to get everything and anything that I can give them. Your endorphins are working. You push through a lot of stuff that you would generally go to sleep. But we know this mission is that important . . . you push through the pain . . . everyone does . . . you will do whatever it takes to get them there.

Common Knowledge. This denotes that information is not only known to members of a group but also known to others [19]. The transition from disconnected silos of knowledge to an interconnected, transparent knowledge base can have a profound impact on patient safety and en route care quality and costs. "If there was a way we could have our systems communicate with each other, I think that would be overall, looking at the big picture, probably the best patient safety thing we could do." Disconnected, inefficient EHRs [electronic health records) and paper-based silos limited real-time information and possible alerts related to patient safety.

> "We had a, Norco and Vicodin, two of the same medications, one guy he was just taking both, which understandably, it's two separate drugs, to him. But, when you look its hydrocodone and acetaminophen . . . now he's doubling up on the dose and taking way over the amount, safe acetaminophen levels."

Ergonomics. Also known as human factors engineering, ergonomics has been described as the science of designing products, processes, and environments that take account of the capabilities of the people who will interact with them [20]. By mistake-proofing the environment, patient and crew safety can be enhanced. The lack of real-time patient information and medication reconciliation and the cumbersome process of recording patient care electronically were a common concern among staging and AE personnel.

> Really, we only have 20 minutes because we have to be sitting and strapped in before grabbing the printer and then this other guy needs it halfway across the plane who needs the printer because we've only got one. Oh and not to mention we might be entering a critical phase of flight now so we really need to be getting our checklist. To find out operationally what we need to do. Get your gloves on. And none of these 7 computers communicate with each other, so we've got to make a disc out of 7 computers and share the printer for everybody's things so . . . got to hurry up because there's 80 people at the door at Andrews.

Factors other than just alcohol (e.g., fatigue) may also negatively affect the cognitive abilities of providers [21]. Even though crews may be within a standard crew duty day, certain missions were identified as being overly fatiguing.

> It's hard to maintain focus sometimes, especially when you go from here to Andrews and then that final leg from Andrews to Texas, everyone is starting to drop out like flies. And it's hard to maintain focus and energy and patient care focus on that last leg.

Incidental Finding

The roles that the staging teams and AE crews played in bringing the wounded home emphasized the passion that surrounded each mission. "The nursing profession allows you to do what you're called to do, to care for people who are appreciating the fact that you're caring for them, that's more motivation than you'll ever need, it's self-fulfilling."

However, the excitement of the mission and sense of making a real difference "carried over into my personal life." Several participants considered changes to their lives and careers after their deployments ended.

> I couldn't go back to an in-patient unit and I don't think I could work in a clinic either . . . I don't know if I could go from working with these wounded guys, to doing any other type of medical care, I love this job but outside from here…there is going to be a decision to be made in my future.

Some en route personnel were beginning to disengage from the demands that are required to accomplish en route care. "I am burned out. I used to love it. It was the best job in the world…the only reason I stay is because of the patients. I'm contemplating getting out because there are so many requirements that infringe on your personal life."

Limitations

Although two researchers knowledgeable about qualitative methods conducted the focus groups, a researcher who was experienced with en route care but was not involved in the development of the study conducted the narrative analysis. Systematic steps were documented and one of the original researchers was available to confirm codes, code families, and findings. Transferability to Air National Guard staging and AE personnel may be limited, as they were underrepresented in the sample.

CONCLUSIONS

The experiences provided by 69 health care personnel revealed the state of en route patient safety. Support of the mission and a mindful emphasis on safety were evident as a range of patient safety concerns and proposed solutions emerged from the focus group discussions. The importance of teamwork, increasing and applying group knowledge, and designing a safe environment through streamlining or implementing technologies that promote safety and prevent care missteps surfaced as means to improve patient safety. Adopting these solutions depends on the projected costs and benefits to the en route care system and DoD medical services in general, especially as novel interventions (e.g., hemorrhage, environment, and pain/sedation control, etc.) are introduced to manage potentially survivable injuries in modern combat.

Phase III

En Route Medication Discrepancies: By the Numbers

BACKGROUND

Interest in patient safety was fueled by the publication of the Institute of Medicine's report [1] that highlighted the risks of medical care and shocked the general public with estimates of serious adverse events and error-related deaths. The practice of health care personnel involves managing the gaps that are a part of a complex environment. Identifying these gaps and how health care personnel anticipate, detect, and bridge them are an important step in understanding barriers and improving patient safety [22-24].

The aims of this phased exploratory mixed-methods study were to determine within the strategic aeromedical evacuation system (a) the perceived safety culture, (b) patient safety concerns, (c) possible solutions to en route care patient safety issues, and (d) medication discrepancies in the patient movement records and the potential of these discrepancies to harm the patient. During the first phase, a survey was distributed to air staging and AE personnel to obtain an overall picture of patient safety. A qualitative approach was used for the second phase of the study to gain personal insight into en route care. The third phase of this study was a retrospective review of medication discrepancies. The findings of the record review are described in this section.

METHOD

Following IRB approval (F-WR-2011-0162N), a retrospective review of 224 de-identified archived patient movement records was conducted to examine the frequency and type of medication discrepancies that occurred within one-half hour prior to and during flight. A separate team of researchers investigated the documentation of en route pain/sedation medication administration. Findings related to documentation of pain/sedation medications are included in this report.

This review included records dated between April 2012 and September 2013. Physician orders were compared with the transcribed orders on the medication administration record (MAR). Scheduled and as-required (PRN) medications were examined for number of medications ordered, accuracy of transcription, and documentation of administration. Discrepancies were assessed for omission (medication listed in the orders but not given), commission (medication given but not ordered), and potential to harm [25,26]. The eight rights of medication administration were used to further document errors and near misses [27]. Univariate statistics were used to describe general medication information. Bivariate statistics were calculated to identify associations between variables.

Statistical definitions are as follows:

- **Minimal harm.** This error is unlikely to cause patient discomfort or clinical deterioration (e.g., vitamins, stool softeners) [25,26].

- **Moderate harm.** This error has the potential to cause moderate discomfort or clinical deterioration (e.g., oral antibiotics, prophylactic dose anticoagulants, oral neurologic agents) [25,26].
- **Severe harm.** This is described as having the potential to result in severe discomfort or clinical deterioration (e.g., intravenous analgesics and oral narcotics, full dose anticoagulants) [25,26].
- **Error.** Ferner and Aronson [28] defined a medication error as a failure in the treatment process that leads to, or has the potential to lead to, harm. An error may be knowledge based, rule based, action based, and/or memory based.

RESULTS

Data were entered into SPSS version 19 for analysis. Nine records were removed due to large amounts (>50%) of missing information. Thus, the analytic sample consisted of 215 patient movement records. A summary of the aggregated data is displayed in Table 10.

The number of ordered and transcribed scheduled medications ranged from 0 to 10, while the number of ordered and transcribed PRN medications ranged from 0 to 7. A little over half of the patients (n = 110, 51%) received four or fewer medications during flight. Inpatients comprised almost half (n = 94, 44%) of those patients transported.

Just 81 (38%) patients were identified on the provider's orders as a self-medicating (SAM); 126 (59%) were not. Four percent of patients were identified as both a SAM patient and a non-SAM patient. Some non-SAM patients were identified in the MAR as administering their own medications. The method of medication administration (self-medicating or flight nurse) was unknown for eight patients. The majority of patient medications [146 (68%)] did not require documentation of quantity upon enplaning and deplaning. However, 23 (11%) did require handoff counts that were not documented completely.

Documentation of the counts was not always evident in the records. Four of the six patients with PCA had pain scores and narcotic counts annotated. Two of the four patients receiving epidural analgesia had pain scores and handoff counts documented. In addition, SAM narcotic counts were rarely documented. Sixty-four SAM patients had pain medications ordered. A little over half of these patients (n = 33, 51%) had their medications documented; 31 (48%) did not.

Ninety-eight non-SAM patients had pain medication ordered. The majority (n = 62, 63%) of these patients had their pain medication documented. However, 36 (37%) did not have their pain medications documented appropriately.

Table 10. Summary of En Route Medication Data (N=215)

Variable	Data
No. of Medications, range	
Ordered Medications	
Scheduled	0-10
PRN	0-7
MAR	
Scheduled	0-10
PRN	0-7
Medications Delivered En Route	
No.	875
Range	0-26
Avg No. Administered to 51% of Patients	≤4
Patient Status, *n* (%)	
Inpatient	94 (44)
Outpatient	120 (56)
SAM, *n* (%)	
Yes	81 (38)
No	126 (59)
Unknown	8 (4)
Documented Counts of Controlled Medications, *n* (%)	
Yes	38 (18)
No	23 (11)
Unknown	8 (4)
Not Required	146 (68)
Transcription, *n* (%)	
Orders/MAR Match	169 (79)
Orders/MAR Do not Match	30 (14)
Unknown	16 (7)
Error Type[a], *n* (%)	
Omission	56 (63)
Commission	33 (37)
Harm[a], *n* (%)	
Minimal	32 (35)
Moderate	46 (52)
Severe	11 (12)

[a]Error and harm percentages calculated using the number of errors (n=89) identified.
Note: Due to rounding error, percentages might not equal 100%.
Unknown data include missing information.

Overall, medication discrepancies were identified in 66 records. Thus, 31% of the 215 records contained some type of medication discrepancy. There were 875 medications administered, which provided 875 opportunities for error. Eighty-nine medication errors were identified. Therefore, there was a 10% chance that each medication administered might result in an error. The majority of errors 56 (63%) were due to omissions, specifically when the order included a range (e.g., Percocet i to ii tabs, morphine 4 to 8 mg). The commission of errors occurred 37% of the time (33 errors), especially when a medication was given but not included in the physicians orders or documented as a voice or telephone order on the MAR. Likewise, some medications were lined out on the MAR, but documentation that the medication had been discontinued was not observed. The majority of errors had the potential to cause moderate discomfort or clinical deterioration (e.g., late doses of oral antibiotics or prophylactic anticoagulants). The potential for severe harm was noted particularly with analgesic medications

(e.g., Percocet and Norco or Percocet and intravenous morphine given at the same time or within a half hour). Generally, intravenous morphine and Percocet were the most frequently ordered PRN analgesic combination.

Of the eight rights of medication administration, errors involving the right documentation occurred 53 (60%) times followed by right dose (n = 39; 44%), right medication (n = 19; 21%), right time (n = 11; 12%), right reason (n = 3; 3%), right route (n = 4; 5%), and right patient (n = 1; 1%). The right response was not recorded fully. Just 34 (35%) of those patients who received pain/sedation medication en route had both pre- and post-administration pain scores documented.

Pearson's correlations suggested a significant moderate association between trip segments and documentation on the MAR, transcription errors, and the number of medications administered while en route. There was a significantly weak association between SAM and the number of medications. Narcotic counts were significantly related to the number of ordered and PRN medications on the MAR, transcription errors, and the number of medications administered during flight. Other significant relationships were seen between the number of medications administered during flight, the number of ordered medications, and transcription errors. Patient status (inpatient or outpatient) was not associated with any of the variables (see Table 11). Simple regression analysis revealed that the majority of transcription errors (R^2 = .96, F (2,212) = 2020.18, p =.000) were explained by the number of PRN medications on the MAR (b = .52, p =.000) and the number of medications administered en route (b = .48, p =.000).

Table 11. Correlations Between En Route Medication Factors

Variable	1	2	3	4	5	6	7	8	9	10
1. **Trip Segment**	-									
2. **Inpatient or Outpatient**	.09	-								
3. **SAM**	-.01	-.01	-							
4. **Ordered Scheduled Medications**	-.06	-.01	-.01	-						
5. **Ordered PRN Medications**	-.06	-.01	-.02	**.99**[a]	-					
6. **Scheduled Medications on MAR**	**.26**[a]	-.012	.07	-.02	-.02	-				
7. **PRN Medications on MAR**	**.34**[a]	-.012	.13	-.02	-.02	**.79**[a]	-			
8. **Transcription Errors**	**.32**[a]	-.02	.13	-.02	-.02	**.82**[a]	.97	-		
9. **Total Number of Medications Administered**	**.33**[a]	-.02	**.14**[b]	-.02	-.02	**.85**[a]	**.94**[a]	**.97**[a]	-	
10. **Narcotic Counts**	.10	-.03	.09	**.35**[a]	**.35**[a]	**.29**[a]	**.40**[a]	**.41**[a]	**.43**[a]	-

[a]Correlations significant at the .01 level (2-tailed).
[b]Correlations significant at the.05 level (2-tailed).
Note: Bolded numbers indicate significant associations.

Three trip segments were included in this review. Final patient destinations included Andrews, San Antonio, and Germany. Summary of each segment's medication information is included in Table 12.

Table 13 displays the correlations for the Andrews and Germany trip segments. On the Andrews segment, narcotic counting errors were significantly associated with all of the variables except SAM and patient status (i.e., inpatient or outpatient). However, SAM and patient status were significant, but weakly correlated. Simple regression suggested that 67% of the missed narcotic counts (R^2 = .67, F(5,108) = 42.84, p = .000) were explained by the number of medications administered (b = .58, p = .000).

Table 12. Trip Segment Medications (N=215)

Destination Port	Andrews (*n*=114)	San Antonio (*n*=32)	Germany (*n*=69)
Number of Medications, range			
Scheduled ordered	0-8	0-8	0-10
Scheduled on MAR	0-8	0-8	0-10
PRN ordered	0-6	0-6	0-7
PRN on MAR	0-7	0-6	0-7
Medications Range	0–18	0–11	0–26
Average Delivered En Route	≤4 = 50%	≤1 = 50%	≤5 = 52%
Patient Status, *n* (%)			
Inpatient	54 (47)	5 (16)	36 (51)
Outpatient	60 (53)	27 (84)	33 (48)
SAM, *n* (%)			
No	68 (60)	9 (28)	49 (71)
Yes	41 (36)	23 (72)	17 (25)
Unknown	5 (4)	-	3 (4)
Controlled Medication Counts, *n* (%)			
No (but required)	13 (11)	9 (28)	1 (1)
Yes (requirement met)	27 (24)	0	11 (16)
Not Needed	71 (62)	23 (72)	52 (75)
Unknown	3 (7)	0	5 (7)
Transcription, *n* (%)			
Orders/MAR match	96 (84)	29 (91)	44 (64)
Orders/MAR do not match	17 (15)	2 (6.3)	11 (16)
Unknown	1 (1)	1 (3)	14 (20)
Errors, *n*[a]	58	4	27
Opportunity for error[b], n (%)	518 (11)	80 (5)	277 (10)
Harm, *n* (%)			
Minimal	21 (36)	1 (25)	10 (37)
Moderate	29 (50)	2 (50)	16 (59)
Severe	8 (2)	1 (25)	1 (4)
Medication Rights, *n* (%)			
Patient	2 (3)	0	0
Medication	10 (13)	2 (50)	7 (15)
Dose	23 (30)	1 (25)	14 (30)
Route	0	0	1 (2)
Time	9 (19)	0	2 (4)
Documentation	30 (39)	1 (25)	21 (46)
Reason	2 (3)	0	1 (2)
Response	0	0	0

[a]Errors, the number of medication discrepancies identified.
[b]Opportunity for error equals the total number of medications administered during the segment divided by the number of actual errors. This provides an estimate of the likelihood of making an error per each medication administered.
Notes: Due to rounding error, percentages might not equal 100%. Column percentages based on the segment's n (N = 215).

Table 13. Medication Correlations: Germany (*n*=69) Lower Matrix; Andrews (*n*=114) Upper Matrix

Variable	1	2	3	4	5	6	7	8	9
1. Inpatient/Outpatient	-	**.21**[a]	.08	.08	-.11	-.11	-.10	-.11	-.06
2. SAM	-.03	-	-.02	-.02	-.02	-.02	-.02	-.03	-.04
3. Ordered Scheduled Medications	-.12	-.07	-	**1.0**[b]	-.01	-.01	-.01	-.01	**.57**[b]
4. Ordered PRN Medications	.05	-.07	-.02	-	-.01	-.01	-.01	-.01	**.57**[b]
5. Scheduled Medications on MAR	-.05	.11	.09	-.20	-	**1.0**[b]	**1.0**[b]	**.99**[a]	**.57**[b]
6. PRN Medications on MAR	-.06	.23	-.01	-.11	**.78**[b]	-	**1.0**[b]	**.99**[a]	**.57**[b]
7. Transcription Errors	-.06	**.25**[a]	.01	-.07	**.82**[b]	**.96**[b]	-	**.99**[a]	**.57**[b]
8. Total Number of Meds	-.06	**.25**[a]	.01	-.07	**.82**[b]	**.96**[b]	**1.0**[b]	-	**.57**[b]-
9. Narcotic Counts	-.03	.21	.19	.13	.20	**.40**[b]	**.42**[b]	**.42**[b]	-

[a]Correlations significant at the.05 level (2-tailed).
[b]Correlations significant at the .01 level (2-tailed).
Note: Bolded numbers indicate significant associations.

Similarly, the Germany trip segment suggested strong significant correlations between PRN and scheduled medications on the MAR, the number of medications administered, and transcription errors. Simple regression supported the relationship between errors in transcription and the number of medications administered (b = .33, p = .000). Narcotic counts were significantly correlated with the number of medications administered, transcription errors, and PRN medications on the MAR. However, simple regression calculations did not indicate these factors as contributing to the explanation of narcotic count errors.

The correlations suggested that the number of PRN medications on the MAR and transcription errors went hand-in-hand on the San Antonio segment (see Table 14). In addition, there were significant correlations between the number of medications administered, the number of ordered scheduled and PRN medications, and the number of scheduled medications on the MAR.

Table 14. Medication Correlations: San Antonio (n=32)

Variable	1	2	3	4	5	6	7	8	9
1. Inpatient/Outpatient	-								
2. SAM	.31	-							
3. Ordered Scheduled Medications	-.26	-.11	-						
4. Ordered PRN Medications	-.24	-.11	.32	-					
5. Scheduled Medications on MAR	-.26	-.11	1.0[a]	.31	-				
6. PRN Medications on MAR	.08	.11	-.06	.01	-.06	-			
7. Transcription Errors	.08	.11	-.06	.01	-.06	**1.0**[a]	-		
8. Total Number of Meds	.23	.09	**.74**[a]	**.46**[a]	**.74**[a]	-.09	.09	-	
9. Narcotic Counts	.11	-.24	.16	-.24	.16	.11	.11	-.06	-

[a]Correlations significant at the .01 level (2-tailed).
Note: Bolded numbers indicate significant associations.

DISCUSSION

Overall, 875 medications were administered and 89 (41%) discrepancies were discovered. Therefore, crew members had a 1 in 10 chance to commit a medication error while administering medications en route. The majority of errors (commission) and documentation of the right medication were associated with inaccurate transcription. These errors were usually associated with PRN medications and SAM status. Discrepancies associated with controlled substance count documentation during handoffs were usually associated with SAM patients carrying narcotics and analgesics. This was especially true on the San Antonio segment. The San Antonio trip segment appeared to have fewer transcription discrepancies and fewer opportunities for error than the Andrews or Germany segments, but a greater percentage of required controlled medication counts were not documented.

A variety of pre-printed, hand-written, and medication stamps was used to order a patient's medication regimen. However, some medication orders appeared side-by-side or were stamped over or written through, making it difficult to decipher which orders were the most current.

Charting of the time, route, and the right dose accounted for the majority of documentation (omission) errors, especially with analgesic and narcotic medications. Because of these documentation errors and the medications involved with these discrepancies, moderate to severe harm to a patient could have occurred.

Although this review of the patient movement records identified trends related to en route medication discrepancies and the potential to harm, any generalizations about the relationships presented in the study should be interpreted cautiously, as this study had several limitations. Information regarding the number and acuity of patients and the crew complement on the missions was lacking. AE nurse/technician notes were not included in the sanitized records. Patient movement records were selected, de-identified, and copied by volunteer personnel at the three destinations without principal investigator or associate investigator oversight.

CONCLUSIONS

This retrospective review provided a snapshot of en route medication discrepancies that mirrored those reported in civilian hospital settings [29-32]. Many of these errors occurred due to a lack of knowledge related to potentially harmful medication interactions, unclear communication associated with medication and SAM status, and failure of the AE nurses and technicians to follow correct procedures and protocols related to medication documentation.

Because en route patient care occurs in a less well-controlled environment with little immediate medical backup available, AE nurses and medical technicians need support and education to meet patient care needs during flight.

Criteria for patient SAM status during AE need review and clarification, especially when the patient is carrying and self-administering several analgesics or sedatives. Provider orders related to SAM need clarification on the order sheet rather than a *yes* or *no* checkbox. Numerous records had both boxes either checked or not checked or were written over.

Providing AE nurses and technicians with clear medication orders allows the nurse to cross-check the orders with the MAR. Many records had several different physicians' orders, some contradictory, on the same sheet without date and time annotated. It was difficult to determine which set of orders was the most recent. The CASF flight surgeons who reconciled

the patients' medications and clarified the en route medication orders deserve kudos. However, transcription and documentation errors still occurred.

En route care providers could benefit from automated *medication alerts*, especially when patients are prescribed numerous analgesics and sedatives. Additionally, proper notation of time, routes, dose, and responses on the MAR needs to be emphasized, and random record reviews by squadron clinical nurse specialists or safety officers to help correct discrepancies with MAR documentation could diminish medication documentation discrepancies.

REFERENCES

1. Kohn LT Corrigan JM, Donaldson MS, eds. To err is human: building a safer health system. Washington, DC: The National Academies Press; 2000.
2. Frakes MA, High K, Stocking J. Transport nurse safety practices, perceptions, and experiences: the Air and Surface Transport Nurses Association survey. Air Med J 2009; 28(5):250-5.
3. Crocker L, Algina J. Introduction to classical & modern test theory. Orlando, FL: Holt, Rinehart, and Winston; 1986.
4. Sandelowski M. Whatever happened to qualitative description? Res Nurs Health 2000; 23(4):334-40.
5. Sandelowski M. What's in a name? Qualitative description revisited. Res Nurs Health 2010; 33(1):77-84.
6. Cronbach LJ. Coefficient alpha and the internal structure of tests. Psychometrika 1951; 16(3):297-334.
7. Cronbach LJ, Shavelson RJ. My current thoughts on coefficient alpha and successor procedures. Educ Psychol Meas 2004; 64(3):391-418. doi: 10.1177/0013164404266386
8. Lehmann EL. The Fisher, Neyman-Pearson theories of testing hypotheses: one theory or two? J Am Stat Assoc 1993; 88(424):1242-9. doi: 10.2307/2291263
9. Ajzen I, Fishbein M. The influence of attitudes on behavior. In: Albarracin D, Johnson BT, Zanna MP, eds. The handbook of attitudes (pp. 173-221). Mahwah, NJ: Lawrence Erlbaum Associates; 2005:173-221.
10. Morse JM. Qualitative nursing research: a contemporary dialogue, rev. ed. Newbury Park, CA: SAGE Publications; 1991.
11. Miles MB, Huberman AM. Qualitative data analysis: an expanded sourcebook, 2nd ed. London: SAGE Publications; 1994.
12. Reason J. Maintenance-related errors: the biggest threat to aviation safety after gravity? In: Soekkha HM, ed. Aviation safety: human factors – system engineering – flight operations – economics – strategies – management. Utrecht, The Netherlands: VSP BV; 1997:465-70.
13. Sammer CE, Lykens K, Singh KP, Mains DA, Lackan NA. What is patient safety culture? A review of the literature. J Nurs Scholarsh 2010; 42(2):156-65. doi: 10.1111/j.1547-5069.2009.01330.x
14. von Thaden TL, Hoppes M. Measuring a just culture in healthcare professionals: initial survey results. Paper presented at the Safety Across High-Consequence Industries Conference; 2005 Sep 20-22; St. Louis, MO.
15. Marx D. Patient safety and the "just culture": a primer for health care executives. New York: Columbia University; 2001.
16. Weick KE, Sutcliffe KM. Managing the unexpected: assuring high performance in an age of complexity. San Francisco: Jossey-Bass; 2001.
17. Reason J. Human error: models and management. BMJ 2000; 320(7237):768-70.
18. Lewis GH, Vaithianathan R, Hockey PM, Hirst G, Bagian JP. Counterheroism, common knowledge, and ergonomics: concepts from aviation that could improve patient safety. Milbank Q 2011; 89(1):4-38.

19. Lewis DK. Convention: a philosophical study. Cambridge, MA: Harvard University Press; 1969.
20. Gosbee J. Human factors engineering and patient safety. Qual Saf Health Care 2002; 11(4):352-4.
21. Rogers AE. The effects of fatigue and sleepiness on nurse performance and patient safety. In: Hughes RG, ed. Patient safety and quality: an evidence-based handbook for nurses. Rockville, MD: Agency for Healthcare Research and Quality; 2008 Mar. AHRQ Publication No. 08-0043.
22. Cook RI, Render M, Woods DD. Gaps in the continuity of care and progress on patient safety. BMJ 2000; 320(7237):791-4.
23. Cook RI, Woods DD. (1994) Operating at the sharp end: the complexity of human error. In: Bogner MS, ed. Human error in medicine. Hillsdale, NJ: Lawrence Erlbaum Associates; 1994:255-310.
24. Woods DD. Coping with complexity: the psychology of human behaviour in complex systems. In: Goodstein LP, Andersen HB, Olsen SE, eds. Tasks, errors and mental models. London: Taylor & Francis; 1988:128-48.
25. Arora V, Kao J, Lovinger D, Seiden SC, Meltzer D. Medication discrepancies in resident sign-outs and their potential to harm. J Gen Intern Med 2007; 22(12):1751-5.
26. Cornish PL, Knowles SR, Marchesano R, Tam V, Shadowitz S, Juurlink DN, et al. Unintended medication discrepancies at the time of hospital admission. Arch Intern Med 2005; 165(4):424-9. doi: 10.1001/archinte.165.4.424
27. Bonsall L. 8 rights of medication administration. NursingCenter's In the Round. 2011 May 27; Retrieved 15 February 2014 from http://www.nursingcenter.com/Blog/post/2011/05/27/8-rights-of-medication-administration.aspx.
28. Ferner RE, Aronson JK. Clarification of terminology in medication errors: definitions and classification. Drug Saf 2006; 29(11):1011-22.
29. Barker KN, Flynn EA, Pepper GA, Bates DW, Mikeal RL. Medication errors observed in 36 health care facilities. Arch Intern Med 2002; 162(16):1897-903.
30. Brady AM, Malone AM, Fleming S. A literature review of the individual and systems factors that contribute to medication errors in nursing practice. J Nurs Manag 2009; 17(6):679-97. doi: 10.1111/j.1365-2834.2009.00995.x
31. Fry MM, Dacey C. Factors contributing to incidents in medicine administration. Part 1. Br J Nurs 2007; 16(9):556-8.
32. Wolf ZR. Medication errors and nursing responsibility. Holist Nurs Pract 1989; 4(1):8-17.

APPENDIX

Safety Initiatives Used in Aviation and Their Application to En Route Care

Safety Initiative	Use in Aviation	Application to Patient Safety in En route Care
Checklists	Pilots use three types of checklists: read and do, challenge and response, aide memoire	AE crewmembers use aide memoire checklists during all phases of flight. Many medical emergency protocols are in the form of an algorithm similar to a read and do checklist. ASFs may develop checklists for staging patients.
Crew resource management (CRM)	The importance of using all available resources, information, equipment, and people to ensure safe operation of the aircraft	CRM is an important part of mission accomplishment for AE and ASF crews/teams.
Joint safety briefings	These pre-departure sessions often include updates on a safety or notices that pertain to the timing and route of the mission	AE crew will usually conduct pre-departure and after-mission briefings. Pre-departure briefings are also jointly conducted with the "front-end" crew to discuss any pertinent patient concerns. ASF teams may conduct periodic briefing regarding patient handoffs and staging.
Minimum safety requirements	Pilots require basic installation requirements such as fire coverage, navigational aids, etc.	In addition to basic installation requirements, AE and ASF crews require basic patient and crew safety conditions such as anti-hijacking and handling of patient litters and/or equipment.
Sterile cockpit rule	During critical phases of flight, pilots and crew refrain from nonessential activities	AE crews not only refrain from nonessential activities during critical phases of flight, but also while administering and documenting treatments and/or medications to patients. ASF patient-focused care is also accomplished using the sterile cockpit rule.
Alternation of roles	Pilots and co-pilots alternate between flying and nonflying duties	AE nurses and technicians alternate roles. ASF alternates roles in a limited manner due to staffing. ASF and AE crews do not intermix or alternate roles.
Standard layout	Flight deck instrumentation on an aircraft is set out in a standardized way	Guidance exists for basic aircraft configuration for patients, but configuration is dependent on mission, patient, and cargo needs. ASF configurations are based on location, resources, and mission needs.
Black box	The flight recorder captures multiple flight parameters	Multiple patient care parameters are captured by the AE crew and ASF teams while the patient is in their care.
Corporate training responsibility	Pilots receive standardized training throughout their career	AE and ASF crews receive initial basic training. Refresher training is conducted periodically for AE crews, but less so for ASF personnel.
First-names-only rule	Using first names can flatten the social hierarchy and foster a culture of open communication	First names are routinely used by AE crews and most of the time by ASF teams.
Incentivized no-fault reporting	This offers the incentive of anonymity and immunity to those who report an unsafe situation and build a constructive safety attitude	A just culture exists within the en route care system where open, transparent communication and reporting of issues are encouraged.
Bottle-to-throttle rule	Alcohol adversely influences visual-spatial skills, dexterity, and management and task completion	AE crews observe this rule and pre-departure crew rest (hours-to-power). Due to the irregularity of missions and staffing, ASF teams may not have the opportunity for crew rest.

Safety Initiative	Use in Aviation	Application to Patient Safety in En route Care
Mistake-proofing	Systems are designed so the user finds it difficult or impossible to make a mistake due to forgetfulness, lack of experience, inattention, or work overload	AE and ASF crews, who were a blend of Guard, Reserve, and active duty, brought a mix of flight and patient care experience. Several algorithms and checklists are available to guide decision-making during patient care episodes.
Forcing functions	These systems try to correct for human errors as they occur (e.g., collision avoidance system)	Some medical equipment used for the patient has a lock-out capability that can prevent patient harm (i.e., PCA pumps). Automated “best practice alerts” can signal missteps and prevent harm (e.g., medication interactions) but are not available to en route providers at this time.
Flight envelope protection	This is a set of limits on the controls of an aircraft that prevent the pilots from commanding a plane so that it exceeds its operating limits	Currently, AE regulations offer guidance to AE crews so they do not overextend their ability to appropriately care for patients (e.g., augmented crews, Critical Care Air Transport teams).

LIST OF ABBREVIATIONS AND ACRONYMS

AE	aeromedical evacuation
AFI	Air Force instruction
AMC	Air Mobility Command
CASF	contingency aeromedical staging facility
CI	confidence interval
CRM	crew resource management
DoD	Department of Defense
EHR	electronic health record
EMED	emergency medical
FTU	Flight Training Unit
GPMRC	Global Patient Movement Requirements Center
IRB	Institutional Review Board
M	mean
MAR	medication administration record
MCD	medical crew director
MDG	Medical Group
PCA	patient-controlled analgesia
PRN	as required
SAM	self-administered medication
SD	standard deviation
TACC	Tanker Airlift Control Center